habitat used by many fish species for spawning or as nursery areas for the young. These include forage fish such as killifishes, silversides, and menhaden, and food fish like flounders, herrings, shad, and white perch. The sudden impact of massive quantities of silt and soil chemicals into the tributaries must have had an impact upon the reproductive success of these and other species. The demersal eggs of some fish, for example, would have been more frequently covered by sediment. There is a strong possibility that the reduction in the populations of some species began in the late 18th and early 19th centuries. A brief survey of historical documents failed to uncover any evidence of a change in fish abundance but this is not surprising. Given the extraordinary abundance of fish that originally existed in the Chesapeake, it would have taken a major reduction in their numbers to be noticeable to the casual observer and thus warrant comment. Accurate records of Chesapeake fish harvests only begin in the mid-19th century and the best data are from the 20th century.

This is of relevance because the later 19th century data cannot be considered indicative of the original abundances. Our fisheries records may begin in the midst of a decline rather than before it started. It is also likely that by the mid-19th century, the composition of the Chesapeake fish population was significantly altered from what it had been when colonization began. More research is clearly necessary but the available data imply that changes in the Chesapeake due to anthropogenic factors were well advanced by the time the first accurate fisheries data became available.

What impact did the extensive siltation have on the fish populations in specific tributaries? Is there any real evidence of a change? To answer this, data are necessary from 19th century sites in the same area where earlier sites have also been excavated. Unfortunately, little effort has been directed at sites of this period in the Chesapeake region but there are some data from 19th-century sites in St. Mary's City that warrant consideration.

Like many other streams in Maryland during the late 18th and early 19th centuries, the St. Mary's River experienced a greatly increased rate of siltation. A good example is a small tidal stream, known today as St. John's Pond, which flows into the St. Mary's River at the site of the 17th-century capital. This stream was open to the river in the mid-18th century and sufficiently deep for sailing vessels to enter and tie up at a landing on the interior. Over the course of the next sixty years, this pond filled with a great amount of sediment and the opening to the river began silting shut. An 1824 map reveals that this entrance was so clogged with sediment that a road was constructed across it.

Faunal materials dating to the 19th century are available from the Tolle-Tabbs site, located one quarter mile from St. John's Pond and within a mile of many of the 17th and early 18th-century sites discussed previously. Tolle-Tabbs was a private home, constructed about 1740, and that stood until about 1860. The vast majority of the archaeological deposits on the site date between about 1830 and 1860, when the structure was occupied by a series of tenants. Faunal remains from these deposits have been studied and they display a strikingly different composition from that found on the nearby colonial sites.[32] Elements from striped bass and bluefish are present, along with bones from members of the Family Clupeidae, probably the American shad (*Alosa sapidissima*). The most abundant remains, however, are from the oyster toadfish (*Opsanus tau*) and especially the striped burrfish (*Chilomycterus schoepfi*). No bones of the readily identifiable burrfish have been found on any colonial site in the area, and toadfish remains are rare. Sheepshead and drum bones are completely absent from the Tolle-Tabbs site, in striking contrast to every colonial site in St. Mary's City.

The absence of these species is almost certainly not due to a reluctance to consume them; the sheepshead was widely regarded as one of the best eating fish in the Chesapeake. Both the sheepshead and drum could be easily taken with the simple hook and line, which even a poor tenant family could have afforded. It is inconceivable that they would have ignored such an easily caught and delicious food source if available, while consuming less desirable species such as toadfishes and burrfishes. The most likely explanation is that sheepshead and drums were no longer present in the waters near the site. Toadfish and striped burrfishes may have become more abundant.

Although not yet analyzed, another sample of animal remains from this period has been excavated at the c. 1840 Brome Plantation, also in St. Mary's City. A preliminary examination indicates that sheepshead and drum remains are very rare or absent in this sample. All of this suggests that there was a significant change in the ecology of the St. Mary's estuary between the mid-18th century and the mid-19th century. In particular, the benthic habitat appears to have been significantly modified. Sediment core analysis by Grace Brush (this volume) reveals that the flora and microfauna in the benthic environment of tributaries was severely affected by sedimentation, thus lending support to the archaeological findings. Although the evidence is still quite limited, it suggests that major transformations of the ecology and the fish populations in the St. Mary's River were occurring during the early 19th century. Almost certainly, other tributaries of the Chesapeake were undergoing similar changes.

Archaeology and Ecological Insights: The Potential

Archaeological sites contain a virtually untapped record of past ecosystems. Fish remains from sites attest to the presence of various species and provide some means of inferring relative abundances. Identifying changes in fish distributions and populations is therefore possible. Determining why they changed is a harder task that requires data on many other aspects of the ecosystem, data that are either non-existant or difficult to extract from the historical record. Fortunately, the same pits and cellars that yield fish remains also contain a diversity of ecological data locked in the shell of the oyster.

Oysters can be thought of as small environmental monitors, constantly recording data about the surrounding aquatic environment during their lives. Through the archaeological excavation and dating of the shells, these molluscan sensors can be placed into a precise temporal sequence and their data banks on the Chesapeake environment decoded. Work by Bretton Kent has revealed the diversity of insights obtainable from the shells.[33] Analysis of the various organisms that lived on or in the shell, for example, can reveal the water salinities and nature of the benthic habitat. Many benthic organisms, such as the burrowing sponges *Cliona* sp., have specific salinity requirements and leave indications of their presence on the shells. By identifying and counting their frequencies on shells, an indication of the prevailing salinities in the waters near a site at specific times can be obtained.

Oyster shells can also tell of the bottom conditions in which they grew. Shell shape, for example, reflects the nature of the substratum upon which an oyster lived. By studying this and other attributes of the shell, the changing bottom conditions in specific locations can be traced over hundreds and perhaps thousands of years. There is the possibility that many collections of oysters from sites can also provide precisely dated samples of bottom sediments. This is due to the activities of the oyster mud worm (*Polydora websteri*) which burrows into the edges of the shell and creates cavities that later fill with sediment. On many shells from colonial sites, these "mud blisters" remain intact and when opened, are found to contain sediment. With sufficient shell collections from a given locality, it is possible that a sequence of well dated sediment samples can be obtained.

Other ecological clues lie hidden in the hinge area of the oyster shell. This is a location where annual, seasonal, and probably daily growth rings are laid down and they can be read through various analytic methods. Variation of average growth rates in shells from different periods could be used to learn how nutrient availability changed in a tributary. Climatic information can also be obtained from these shells since major storms, periods of severe cold weather or drought all influence shell growth by affecting the surrounding aquatic environment. The collection and study of oyster shell samples from rural sites along the Chesapeake offers tremendous potential for tracing the past ecology of the estuary. When combined with data from archaeological fish remains, these independent sources of evidence can provide a remarkable record of the estuarine conditions and help determine how and why they have changed.

Summary and Conclusions

Review of the historical and archaeological records from the 17th and 18th-century Chesapeake provides a number of important insights pertaining to the colonists' use and transformation of this estuary. Over most of the colonial period, the colonists appear to have had little impact upon the Bay's ecosystem. Agricultural practices were of the type that required large quantities of land and provided sustained yields without permanently degrading soil resources or causing serious erosion. Fishing activities focused on the benthic habitat over most of the colonial period. Given the simple fishing equipment and small human populations, it is unlikely that harvesting pressure was sufficient to have any impact upon the fish populations.

Only in the late colonial period did significant ecological change begin to occur. Large sections of the Piedmont were under cultivation or being actively cleared for plow agriculture. In the Tidewater area, due to both human demography and economic forces, the land tenure system and agricultural practices changed during the last quarter of the 18th century. Evidence suggests that after 150 years of use, the soil conserving method of shifting field agriculture was rather quickly abandoned for an "Improved" agriculture based on intensive plowing and field fertilization. The new method may have provided better yields but its unanticipated side effects were widespread surface erosion, deterioration of soil resources, and rapid sedimentation in the tributaries of the Chesapeake. By 1820, significant changes were occurring in estuarine ecology and the aquatic resources. This is a clear example of the impact that changing land use practices can have on estuaries.

The Chesapeake region has been occupied for thousands of years by a variety of cultures who perceived and exploited the environment in a diversity of ways. These peoples have left us a remarkable legacy, formed quite unintentionally through the process of daily life. By depositing artifacts and food waste into the ground, they created thousands of time capsules that not only tell of their lives but of the environment they inhabited. Through the study of this archaeological record, and the surviving historical accounts, it is possible to gain a unique insight into the evolution of the Chesapeake. This paper represents a first effort at synthesizing the research findings of archaeologists and historians to better understand how and why the Chesapeake has changed. These data sources have tremendous potential for the development of the temporal perspective necessary to preserve and nurture this magnificent estuary.

References Cited

1. **Morgan, E. S.** 1975. *American Slavery-American Freedom.* W. W. Norton & Co. New York.
2. **Menard, R.** 1984. Population, Economy, and Society in Seventeenth Century Maryland. *Maryland Historical Magazine* **79:** 72; **Wells, R. V.** 1975. *The Population of the British Colonies in America before 1776.* Princeton.

3. **Smolek, M. A., D. J. Pogue and W. E. Clark.** 1984. *Historical Archaeology of the Seventeenth-Century Chesapeake.* Jefferson Patterson Park and Museum Occasional Paper 1.
4. **Carr, L. G.** 1974. The Metropolis of Maryland: A Comment on Town Development Along the Tobacco Coast. *Maryland Historical Magazine,* **69:** 124–145.
5. **Mitchell, R. D. and E. K. Miller, eds.** 1979. *Geographical Perspectives on Maryland's Past.* Occasional Papers in Geography No. 4. University of Maryland.
6. **Schoepf, J. D.** 1911. *Travels in the Confederation, 1783–1784.* Lord Baltimore Press. Baltimore; **Earle, C. V.** 1975. *The Evolution of a Tidewater Settlement System.* Univ. of Chicago, Department of Geography Research Paper 170.
7. **Menard, R. R.** 1975. Economy and Society in Early Colonial Maryland. Ph.D. Dissertation. University of Iowa.
8. **Froomer, N. L.** 1978. Geomorphic Change in Some Western Shore Estuaries During Historic Times. Ph.D. Dissertation. The Johns Hopkins University.
9. **Papenfuse, E. C.** 1972. Planter Behavior and Economic Opportunity in a Staple Economy. *Agricultural History,* **46:** 297–311.
10. **Craven, A. O.** 1926. *Soil Exhaustion as a Factor in the Agricultural History of Virginia and Maryland 1606–1860.* University of Illinois Press; **Hall, A. R.** 1937. Early Erosion Control Practices in Virginia. *U.S. Department of Agriculture Miscellaneous Publication* No. 256.
11. **Earle** 1975. "Tidewater Settlement System", 18.
12. **Ibid,** 26–27; **Papenfuse** 1972. "Planter Behavior", 305; **Walsh, L. S.** 1985. Land, Landlord, and Leaseholder: Estate Management and Tenant Fortunes in Southern Maryland 1642–1820, *Agricultural History,* **59:** 373–396, 385.
13. **Hamor, R.** 1957. *A True Discourse of the Present State of Virginia.* Virginia State Library. Richmond. Original 1614.
14. **Miller, H. M.** 1984. Colonization and Subsistence Change On the 17th Century Chesapeake Frontier. Ph.D. Dissertation. Michigan State University.
15. Personal Communication 1985: **Matthew Emerson,** University of California. Berkeley.
16. **Glover, T.** 1904. An Account of Virginia. Original 1676. **B. H. Blackwell.** Oxford, 5.
17. **Miller** 1984. "Colonization and Subsistence Change".
18. **Kent, B. W.** 1980. Patterns of Oyster Utilization in St. Mary's City, Maryland Between 1640 and 1740. Report Submitted to the SeaGrant Program, University of Maryland.
19. **Miller,** 1984. "Colonization and Subsistence Change".
20. **Wharton, J.** 1957. *The Bounty of the Chesapeake.* Virginia 350th Anniversary Celebration Corporation, 54–59.
21. **Middleton, A. P.** 1953. *Tobacco Coast: A Maritime History of the Chesapeake Bay in the Colonial Era.* The Johns Hopkins University Press, Baltimore, 224.
22. Personal Communication 1981; **Lorena S. Walsh.** Colonial Williamsburg Foundation; **Michel, F. L.** 1916. Report on the Journey of Francis Louis Michel, 1701–1702. *Virginia Magazine of History and Biography,* **24:** 1–43.
23. **Earle** 1975. "Tidewater Settlement System, 59; **Papenfuse** 1972. "Planter Behavior".
24. **Stiverson, G. A.** 1977. *Poverty in a Land of Plenty: Tenancy in Eighteenth Century Maryland.* The Johns Hopkins University Press, Baltimore; **Walsh** 1985. "Land, Landlords, and Leaseholders".
25. **Walsh** 1985. "Land, Landlords, and Leaseholders", 390; **Froomer** 1978. "Geomorphic Change".
26. **Lemon, J. T.** 1972. *The Best Poor Man's Country.* The Johns Hopkins University Press, Baltimore.
27. **Taylor, J.** 1813. *Arator: Being a Series of Agricultural Essays, Practical and Political,* 5–6.
28. **Anburey, T.** 1791. *Travels throughout the Interior Parts of America in a Series of Letters.* London, Volume **2:** 360.
29. **Scott, J.** 1807. *A Geographical Description of the States of Maryland and Virginia.* Philadelphia, 121–128.
30. **Gottschalk, L. C.** 1945. Effects of Soil Erosion on Navigation in Upper Chesapeake Bay. *Geographical Review* **35:** 219–238; **Faull, J. F.** 1973. The Structural Growth of Port of Baltimore 1729–1814. M.A. Thesis. University of Maryland, 103–109.
31. **Taylor** 1813. *Arator,* 172.
32. **Miller, H. M.** 1985. A Preliminary Report on the Faunal Remains from the Tolle-Tabbs Site. Manuscript on File, Historic St. Mary's City.
33. **Kent, B. W.** 1986. Making Dead Oysters Talk: Techniques for Analyzing Oyster Shells From Archaeological Sites. Maryland Historical Trust. Annapolis. In Press.

Journal of the Washington Academy of Sciences,
Volume 76, Number 3, Pages 188–198, September 1986

Chesapeake Fisheries and Resource Stress in the 19th Century

L. Eugene Cronin

12 Mayo Avenue, Bay Ridge, Annapolis, Maryland 21403

ABSTRACT

Chesapeake Bay contained large populations of fish, crabs, shellfish, and aquatic plants at the beginning of the 19th century, although harvests were small. Vast spring runs of anadromous fish were increasingly exploited to provide millions of pounds annually until closing of rivers by dams, heavy predation by fishing, and perhaps pollution took their toll. For oysters, the coincidence of the importation of deep-water dredges, development of new technologies, high demand, and the discovery of large unknown beds resulted in a new important industry and changed the ecology of the Bay. The effects of poor management were also discovered. Abundant blue crabs were caught and processed as new methods were perfected and transportation became available. Waterfowl were harvested for food and for sport in large numbers. The environment, which had been injured by sediments from land, received growing quantities of human and industrial wastes, and the first steps toward water pollution prevention were initiated.

The century provides dramatic and large-scale examples of discovery, innovations, exploitation, and decline in fisheries and of the dawning recognition of the needs for scientific understanding, wise management, and the control of pollution.

The Beginning of the Century

As the century opened, the living resources present in the tidal Chesapeake Bay system were rich in variety and enormous in quantity. Vast spring migratory runs of shad, herring, and sturgeon entered the Bay and moved to the tributaries to spawn. Unmeasured but certainly massive populations of oysters, crabs, menhaden and sea-sourced fish were present. Clouds of waterfowl had been observed since colonial days and their presence gives evidence of abundant stands of aquatic vegetation. The high diversity of fish, game, and birds was noted in many reports. As always, the stocks were certainly variable, as noted in the accounts of George Washington and others.

The harvest at that time cannot be measured because there was no system or habit of permanent recording. The scattered records and occasional relevant writings show, however, that the harvest was modest, local, and highly seasonal. Only a few fishing methods were available, those imported by the immigrants or adapted from native Indian practices. These included simple short tongs for shallow-water oysters, small seines, wiers, and primitive fish hooks. The largest harvest was from the spring runs of fish. According to writings of the period, crabs and oysters were not highly esteemed, although oysters were significant in the local tidewater diet (Wharton 1957, Middleton 1953). Colonial management by England had never favored fisheries in the Maryland and Virginia colonies, which were expected to produce tobacco while fishing was encouraged in New England. "Good" salt from Lisbon, Italy, and Cabo Verde was prohibited for the Chesapeake colonies, and only "weak" and inadequate salt from Liverpool was permitted (Beitzell 1968, Bayliff 1971). One of the results of liberation was improvement in the preservation of fish. By 1800, significant production was only beginning.

From the perspective of modern knowledge about the Chesapeake Bay system, we can speculate with a degree of confidence about the environment in the Bay around 1800. All of the many habitats now present were in the system (except for the polluted ones). There was a wide variety of depths and sediment types, the broad seasonal swings in temperature and rainfall were similar to the present, the full gradients from fresh water to marine salinity existed with considerable variation, and the physical circulation patterns were not greatly different. Most of the same species lived in or around the Bay, although significant changes have occurred from introductions and reductions or perhaps extirpations. The populations of humans were relatively small, and included about 350,000 in Maryland and 865,000 in Virginia. Clusters of people were so small that "city" is hardly an appropriate word. Wastes were dumped freely into the nearest waterway, where local effects probably occurred.

The human population had, however, achieved one change that had a substantial effect on the estuary. Land had been rapidly and extensively cleared of trees in the tidewater region, principally for the bare-field culture of tobacco. Iron furnaces were common, demanding mining of about three tons of ore per day and 300 bushels of charcoal to reduce it, causing additional land clearing. These and other activities resulted in massive surface erosion, faster run-off of water, turbidity, filling of headwater areas, larger chemical burdens to the Bay, and eventual down-stream shifts in the salinity patterns.

Still, the observed vast populations of waterfowl and fish provide evidence that they had not yet been destroyed by sediment, increased turbidity, or toxicants.

A Century of Harvesting the Migratory Fish

Shad and several species of herring undertook an anadromous migration from the ocean to spawning grounds during about six weeks of each spring. Gear were developed or adapted to harvest them while they were crowded in the headwater and tributary areas. Runs extended up the Susquehanna into New York State, and at least 40 fishing sites were regularly used along the upper River from Northumberland to Towanda (McDonald 1887). In other tributaries, the runs extended to the fall line. In the upper Bay and Susquehanna River, large floats of logs were constructed and equipped with landing ramps and processing houses (Wright 1967). These were the foci for the operation of 10–15 long seines, which sometimes caught 600 barrels per haul, with 100 or more men employed for each float. Fish were cut, salted, placed in hogsheads and transported by wagons. Shad are described as weighing 3–9 pounds, and as much as 13 (McDonald 1887).

The short-term employees on the floats hardly present a romantic image of good old days. They have been described as wretched, scarcely clothed, and mostly drunk—bringing up the rear of the human race (Royall 1826). Farther up the Susquehanna, near the Maryland-Pennsylvania line, one haul in 1827 is reported to have yielded 100 wagon loads of fish, estimated to include 15,000,000 shad. A 1835 gazeteer published in Virginia stated that 22,500,000 shad and 750,000,000 herring were caught per year in the Potomac River (Bayliff 1971).

Changes were beginning. The first dams in the Susquehanna, far upstream, were built about 1830, and canals were built that diverted a small portion of the river flow. Perhaps the importation and development of new fishing gear, permitting unprecedented harvests from deeper and more open waters, was more important (McDonald 1887). In 1835, gill nets were the principal gear for fish. Pound nets, blocking areas from shallow to moderately deep water, were imported about 1858 from New Jersey, and the revolutionary open-water purse net was brought in from Long Island in 1865. The fisheries were, however, still principally focused on the spring and fall runs, although many new species were taken by these additional techniques.

From 1875 until the end of the century, there was a phenomenal interest in the use of hatcheries to augment stocks. Up to 10,000,000 shad fry were hatched and released each year and efforts were made to hatch salmon, lake trout, European carp, rock and even tench! (Ferguson and Hughlett 1880). Mobile hatchery vessels were created to move among the spawning grounds to permit prompt hatching and release, while other hatcheries were operated at various sites on land. Even the excellent zoologist W. K. Brooks was caught up in the enthusiasm, and described shad as "a domesticated animal," for which "intelligence and knowledge of nature . . . have enabled man to keep up the supply by artificial means" (Brooks 1893, p. 239). It is useful to introduce a later comment, based on extensive review of shad fisheries and management in the Chesapeake and elsewhere (Mansueti and Kolb 1953, p. 85):

> ". . . the honest but mistaken feeling toward hatcheries which seized not only fishermen but biologists at the turn of the century, although even then the premise should not have stood up under more objective scrutiny."

By 1880, there were 160 pound nets in Virginia and two in Maryland, and 60 menhaden factories employed about 800 men (Goode *et al.* 1887). Shad, bluefish, sea trout, menhaden, and mackerel were important to the fisheries. Up to 14,000,000 pounds of shad were taken in the Susquehanna, where fisheries had been reduced down-stream to the Columbia dam, about 40 miles above tidal waters. Gill nets were still the most important gear, and hundreds were fished each night in season in the upper Bay and other tributary areas. Twenty large seines, up to a mile in length, were in use along with the attendant floats or batteries near the mouth of the Susquehanna. Some nets required 2½ days for emptying. The menhaden "swarming our waters in countless myriads" were harvested for oil, fertilizer, and bait (Goode *et al.* 1887). The rock or striped bass was caught only in small quantities.

In the 1880s and 1890s, there was an explosion of printed material of several types on the fisheries of Chesapeake Bay and other areas in the United States. They included a major seven-volume survey and description of the "Fisheries and Fisheries Industries of the United States" by Goode and many others for the U.S. Commission of Fish and Fisheries, scientific summaries (Brooks 1891, 1905; Bean 1883; Ryder 1890; etc.), popular summaries (Brooks 1893; Brooks and Knower 1893), federal and state agency reports (Carroll 1880; Ferguson and Hughlett 1880; etc.), and illustrated newspaper accounts (Anon. 1873, 1874, 1882, 1883a and 1883b). It is not possible to summarize these here, but they describe vigorous and imaginative fisheries, rapidly expanding the exploitation of the Bay's bounty. Figures 1–5 present the available estimates of landings for important finfish. In the 19th century, shad catch increased dramatically (Fig. 1). The take of rock or striped bass (Fig. 2) and of croaker (Fig. 3) was small. Bluefish were

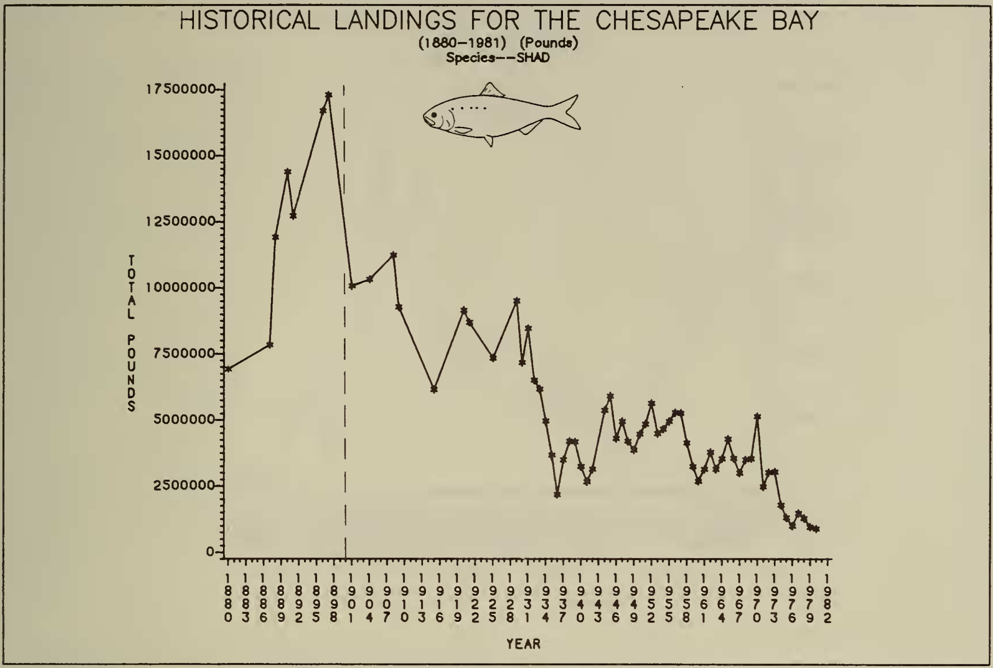

Fig. 1. Available data on landings of shad, *Alosa sapidissima,* for Chesapeake Bay, 1880–1981.

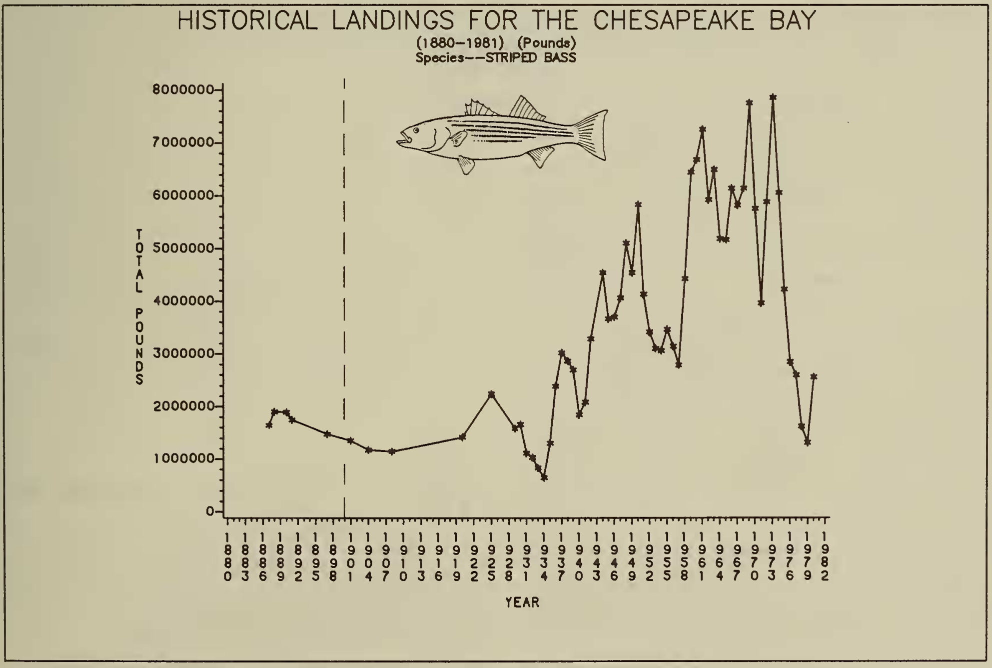

Fig. 2. Available data on landings of rock or striped bass, *Morone striatus,* for Chesapeake Bay, 1880–1981.

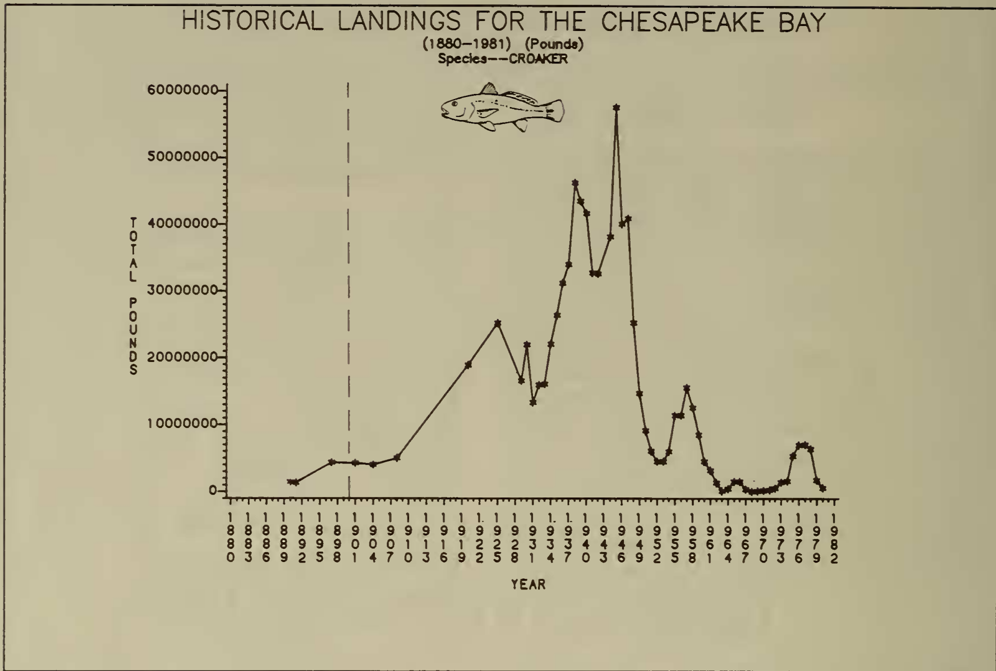

Fig. 3. Available data on landings of croaker, *Micropogon undulatus,* for Chesapeake Bay, 1880–1981.

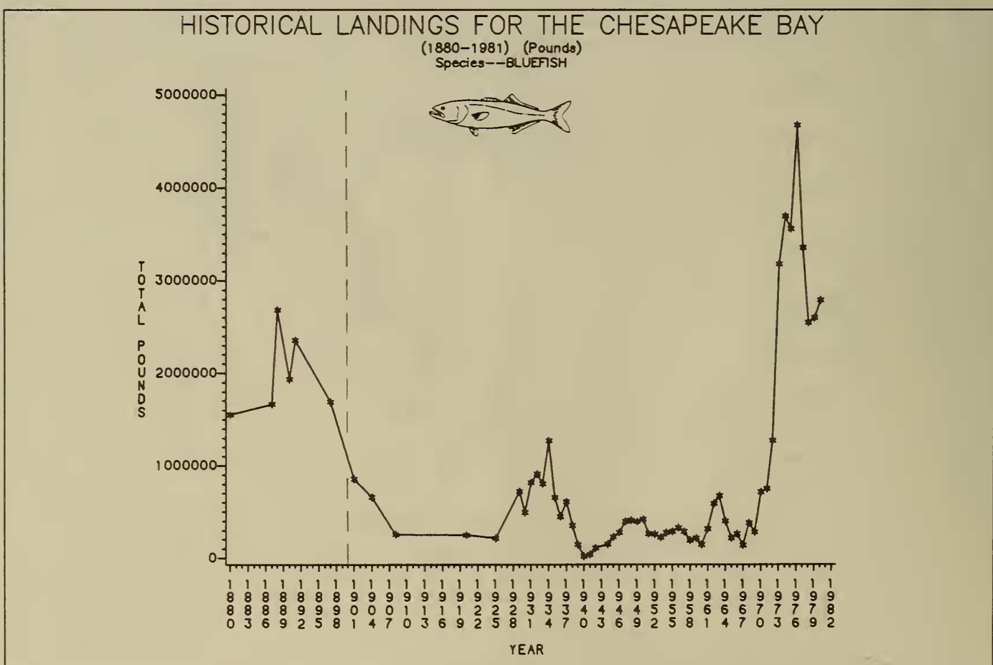

Fig. 4. Available data on landings of bluefish, *Pomotomus saltatrix,* for Chesapeake Bay, 1880–1981.

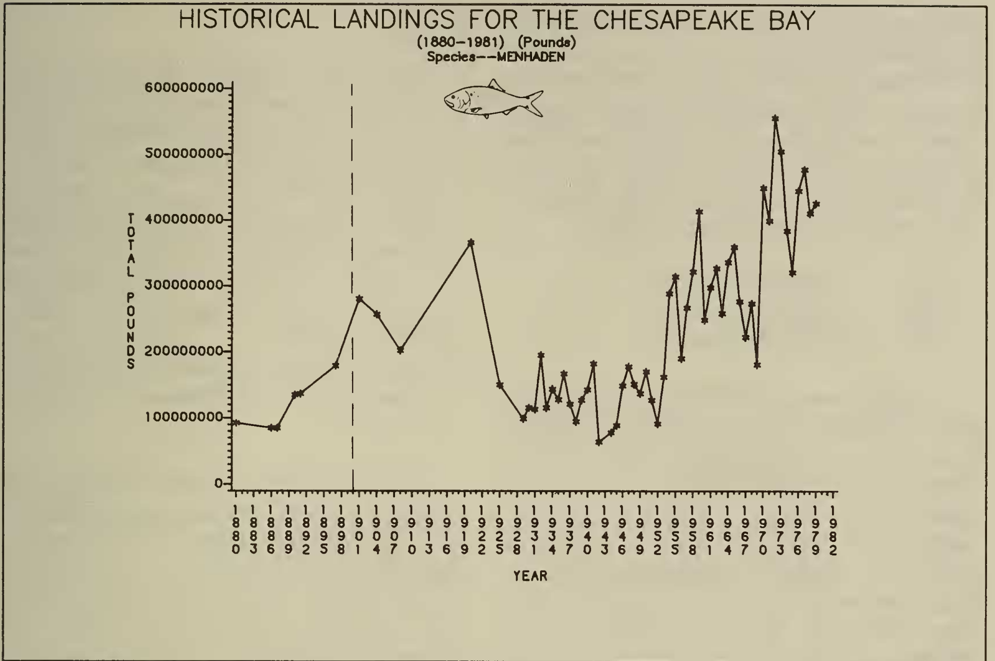

Fig. 5. Available data on landings of menhaden, *Brevoortia tyrannus,* for Chesapeake Bay, 1880–1981.

harvested in significant numbers (Fig. 4), and the capture of menhaden grew to dominate the quantities of fish landed (Fig. 5). Later catches are beyond the scope of this paper, but the perspective they provide on the 19th century patterns is important, so they are included. At the present time, shad are so scarce from the combined effects of over-fishing, damming of tributaries, and pollution that Maryland has prohibited their capture since 1980. Rock or striped bass are under complete moratorium in Maryland and severely reduced harvest in Virginia.

The Sleeping Giant

The very abundant oyster, which had been only locally utilized and sometimes regarded as starvation food by the colonists, was still harvested in relatively small quantities in the early 19th century. Shallow beds furnished perhaps 500,000 bushels per year for local consumption (Bayliff 1971). Depletion of New England beds drove opportunistic Connecticut oystermen to the Chesapeake, however—and they brought their deep-water dredges. New possibilities for both increased harvest and damage to beds immediately appeared and Virginia (1820) and Maryland (1830) outlawed the dredge. Maryland also prohibited transportation of oysters by non-Marylanders.

But the dredge remained, and a series of triphammer events changed the economy of the region and the ecology of Chesapeake Bay. The Baltimore and Ohio Railroad initiated service in 1828 and opened new potentials for distribution (Nichol 1937, Capper *et al.* 1983). Land transport of fresh, pickled, and spiced oysters was well established by 1836 (Nichol 1937). The discovery in 1840 of vast deep-water stocks in Tangier Sound, available only by dredging, encouraged a vigorous frontier industry. In 1845, the "cove" or canned and processed oyster became feasible because a method was perfected for hermetically sealing metal cans. Even the California gold rush, with its demands for portable canned goods for long voyages, added new impetus. The Baltimore oyster industry, greatest in the nation, handled the following quantities of fresh, pickled, and canned oysters (Nichol 1937):

1857 — 1,600,000 bushels
1865 — 4,000,000 bushels
1868 — 10,000,000 bushels

Dredging was legalized in 1865 and a period of unprecedented activity and violence ensued. Over 900 dredges were licensed in Maryland by 1892–93. The handwinders for raising the heavy dredges required many deck-hands and notorious practices of human exploitation existed. Wars developed at state boundaries and when dredgers invaded tonging areas (Wennersten 1981). Crisfield, Maryland, the center of the Tangier Sound oystering, was described as a "raw riotous community with saloons and brothels filled with lusty watermen."

Between 1836 and 1890, about 400,000,000 bushels of oysters were harvested in Maryland with virtually no effort to protect brood stocks, avoid destruction of small oysters, enhance reproduction, or take other protective measures despite the detailed analysis, warnings, and recommendations of scientists and surveyors (Winslow 1880, Brooks 1891, Brooks, Waddell, and Legg 1884). Natural reproduction was no longer replacing the harvest (Brooks 1893, Stevenson 1894). Oyster bars had been destroyed, enforcement of laws and regulations was weak, and the oyster wars were at their worst (Wennersten 1891).

The human effects of the labor-intensive dredge fishery for oysters were graphically and sympathetically described in an almost emotional summary on "oyster dredgers" that appears unexpectedly in a mostly prosaic volume on Maryland industrial statistics by Weeks in 1886. He states:

> "The oyster dredgers of Maryland are the most ill-conditioned body of labor I have met in the course of this inquiry. It is labor that has no home, no money—scarcely clothes. It is poor and beggardly, exposed to cold and hardship without restraint or protection of law. . . . The man who has been dredging oysters 'down on the bay' is a dilapidated specimen. . . . he is never in so good a condition as when subject to the regulations of the Baltimore City jail." (p. 67)

Weeks's interest and concern were aroused. He describes the shanghaiing of men by shipping agents at $2 a head as labor for the handwinders on the deck of the oyster boats, forced labor akin to slavery, atrocious compensation if any, and reported killing by "paying off with the boom." He developed a "synopsis of the fatalities and injuries which came to the public notice during the season of 1884–85, including men abandoned with paralysis, killings, drownings, frost-bite, jaw fracture from the dredge handle, starvation, swollen and wounded "oyster shell hands," injury from the jib-boom, and freezing to death. He vigorously and specifically recommended humane reforms.

Toward the end of the century, declines in the catch began (Fig. 6). Scientific recommendations for management were largely ignored, although measures requiring culling, use of shells to improve the setting of young oysters, and other partial corrections were adopted. Figure 6 shows the relationship of 19th century extensive and intensive exploitation to the subsequent declines. The early explosion of tonging and dredging undoubtedly removed accumulated stocks and it is impossible to make good estimates of the maximum sustainable yield under wise management and in a healthy environment. If, however, the harvest could have been maintained near 70,000,000 pounds